



ATIS STANDARD

ATIS-0100801 04.2005(S2020)

**Multimedia Communications Delay, Synchronization, and
Frame Rate**

AMERICAN NATIONAL STANDARD FOR TELECOMMUNICATIONS



As a leading technology and solutions development organization, the Alliance for Telecommunications Industry Solutions (ATIS) brings together the top global ICT companies to advance the industry's most pressing business priorities. ATIS' nearly 200 member companies are currently working to address the All-IP transition, 5G, network functions virtualization, big data analytics, cloud services, device solutions, emergency services, M2M, cyber security, network evolution, quality of service, billing support, operations, and much more. These priorities follow a fast-track development lifecycle — from design and innovation through standards, specifications, requirements, business use cases, software toolkits, open source solutions, and interoperability testing.

ATIS is accredited by the American National Standards Institute (ANSI). The organization is the North American Organizational Partner for the 3rd Generation Partnership Project (3GPP), a founding Partner of the oneM2M global initiative, a member of the International Telecommunication Union (ITU), as well as a member of the Inter-American Telecommunication Commission (CITEL). For more information, visit www.atis.org.

AMERICAN NATIONAL STANDARD

Approval of an American National Standard requires review by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made towards their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretary or sponsor whose name appears on the title page of this standard.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Notice of Disclaimer & Limitation of Liability

The information provided in this document is directed solely to professionals who have the appropriate degree of experience to understand and interpret its contents in accordance with generally accepted engineering or other professional standards and applicable regulations. No recommendation as to products or vendors is made or should be implied.

NO REPRESENTATION OR WARRANTY IS MADE THAT THE INFORMATION IS TECHNICALLY ACCURATE OR SUFFICIENT OR CONFORMS TO ANY STATUTE, GOVERNMENTAL RULE OR REGULATION, AND FURTHER, NO REPRESENTATION OR WARRANTY IS MADE OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OR AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. ATIS SHALL NOT BE LIABLE, BEYOND THE AMOUNT OF ANY SUM RECEIVED IN PAYMENT BY ATIS FOR THIS DOCUMENT, AND IN NO EVENT SHALL ATIS BE LIABLE FOR LOST PROFITS OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES. ATIS EXPRESSLY ADVISES THAT ANY AND ALL USE OF OR RELIANCE UPON THE INFORMATION PROVIDED IN THIS DOCUMENT IS AT THE RISK OF THE USER.

NOTE - The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, no position is taken with respect to whether use of an invention covered by patent rights will be required, and if any such use is required no position is taken regarding the validity of this claim or any patent rights in connection therewith. Please refer to [<http://www.atis.org/legal/patentinfo.asp>] to determine if any statement has been filed by a patent holder indicating a willingness to grant a license either without compensation or on reasonable and non-discriminatory terms and conditions to applicants desiring to obtain a license.

ATIS-0100801.04.2005(S2020), *Multimedia Communications Delay, Synchronization, and Frame Rate*

Is an American National Standard developed by the ATIS **Network Performance, Reliability, and Quality of Service Committee (PRQC)**.

Published by

**Alliance for Telecommunications Industry Solutions
1200 G Street, NW, Suite 500
Washington, DC 20005**

Copyright © 2020 by Alliance for Telecommunications Industry Solutions
All rights reserved.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher. For information contact ATIS at 202.628.6380. ATIS is online at < <http://www.atis.org> >.

ATIS-0100801.04.2005(S2020)

[Revision of T1.801.04.1997(R2002)]

American National Standard for Telecommunications

**MULTIMEDIA COMMUNICATIONS DELAY, SYNCHRONIZATION,
AND FRAME RATE**

Secretariat

Alliance for Telecommunications Industry Solutions

Approved December 13, 2005

American National Standards Institute, Inc.

Abstract

This standard addresses delay and synchronization issues in Multimedia systems that may combine video, audio, and data channels. Video delay can vary widely over short sequences, audio and video sequences may be distorted during transmission, and data streams can have little or no structure and may contain bit errors. Although each media presents unique measurement challenges, the methods specified here meet and overcome them. This standard also gives considerations for joint measurements and specifications for internal clocks that provide time stamps. Performance standards development proceeds in three stages, specifying parameters, methods of measurement, and (usually numerical) limits for services, networks or equipment. This specification addresses the first two stages, laying a foundation for the third.

FOREWORD

The Alliance for Telecommunication Industry Solutions (ATIS) serves the public through improved understanding between carriers, customers, and manufacturers. The Network Performance, Reliability, and Quality of Service Committee (PRQC) -- formerly T1A1 -- develops and recommends standards, requirements, and technical reports related to the performance, reliability, and associated security aspects of communications networks, as well as the processing of voice, audio, data, image, and video signals, and their multimedia integration. PRQC also develops and recommends positions on, and fosters consistency with, standards and related subjects under consideration in other North American and international standards bodies.

An aspect of true Multimedia Communications Systems that sets them apart from a mere collection of unrelated channels is their ability to maintain a temporal relationship between the different media. This standard specifies the parameters and measurement methods to assess relative synchronization between media channels, and two other key aspects of temporal quality. Transmission time or delay through a channel, is critical when assessing a system's suitability for conversational and other interactive uses. Frame inter-arrival time and its reciprocal, frame rate, characterize a system's ability to deliver information continuously and consistently.

Today's Multimedia systems combine video, audio, and data channels to enhance communications. This standard covers all these media. Video delay can vary widely over short sequences, audio and video sequences may be distorted during transmission, and data streams can have little or no structure and may contain bit errors. Although each media presents unique measurement challenges, the methods specified here meet and overcome them. The Mean Square Error based method expects and measures instantaneous video delay variations if present, setting this approach apart from earlier methods. The audio delay method accommodates channels where the original speech waveform is not preserved and the delay may be time-varying. The data channel methods take advantage of native structures when possible and tolerate bit errors. All the methods allow test signals representative of the intended system application.

Performance standards development proceeds in three stages, specifying parameters, methods of measurement, and (usually numerical) limits for services, networks, or equipment. This specification addresses the first two stages, laying a foundation for the third.

This standard also gives considerations for joint measurements and specifications for internal clocks that provide time stamps. There is also a discussion of time stamp position in informative annex A. Annex B is a guide to the mathematical symbols used in the standard. For those who seek more information, a bibliography of related standards and publications may be found in Annex C. Annex D contains a full definition of the audio delay measurement algorithm described in clause 7, in the form of computer code.

This standard was originally developed by Technical Subcommittee T1A1 (now ATIS PRQC) under the Video Teleconference/Video Telephony Performance and Advanced Television Performance project. The first project began in 1988 under the auspices of Technical Subcommittee T1Q1. The standard's most recent revision (2005) was developed under PRQC Issue A0024. The revised standard complements PRQC's recent specifications covering video test scenes, performance terms and definitions, and other objective measurements.

Suggestions for improvement of this standard will be welcome. They should be sent to the Alliance for Telecommunications Industry Solutions, 1200 G Street, NW, Suite 500, Washington, DC 20005.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee PRQC. Committee approval of this standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the PRQC had the following members:

M. Neibert, PRQC Chair
 N. Seitz, PRQC Vice-Chair
 C. Underkoffler, ATIS Chief Editor
 S. Voran, PRQC Technical Editors

Organization Represented	Name of Representative
Alcatel USA Inc.	Ken Biholar
AT&T	Percy Tarapore Charles A. Dvorak (Alt.)
BellSouth Telecommunications	Archie McCain David M. Brady (Alt.)
C.S.I Telecommunications	Michael S. Newman Thomas G. Croda (Alt.)
Cingular Wireless LLC	Don Zelmer Marc Grant (Alt.)

Organization Represented	Name of Representative
Defense Info. Systems Agency	Chris Fitzgerald
Ericsson Incorporated	Mustafa Kocaturk Susana Sabater-Maroto (Alt.)
Harris Corporation	Marlis Humphrey
Intelsat	Mark T. Neibert
Lucent Technologies	Stuart O. Goldman
MCI	J. Martin Carroll Robert Schafer (Alt.)

ATIS-0100801.04.2005(S2020)

Organization Represented	Name of Representative
National Communications System	An Nguyen
	Jean Trakinat (Alt.)
AT&T	Neal B. Seitz
Portel Networks	Joseph A. Zebarth
Quest	Steve Showell
	Michael Fargano (Alt.)
SBC Communications, Inc.	Randolph Wohlert
	Pierre Costa (Alt.)

Organization Represented	Name of Representative
Siemens Info & Comm Ntwks, Inc.	Suhas S. Gandhi
	David E. Francisco (Alt.)
Sprint Corporation	Mark L. Jones
Telcordia Technologies	Spilios Makris
	Cliff Halevi (Alt.)
Tellabs Operations, Inc.	William A. Walker
	Kevin Stodola (Alt.)
Verizon Communications	John Colombo
	Wendy Pugh (Alt.)

The Quality of Service (QoS) Task Force was responsible for the development of this document.

TABLE OF CONTENTS

1 SCOPE, PURPOSE, & APPLICATION	1
1.1 SCOPE	1
1.2 PURPOSE	2
1.3 APPLICATION	2
2 NORMATIVE REFERENCES	5
3 DEFINITIONS, ACRONYMS, & ABBREVIATIONS	6
3.1 DEFINITIONS	6
3.2 ACRONYMS & ABBREVIATIONS	7
4 FRAMEWORK OF MEASURABLE PARAMETERS	8
4.1 TRANSMISSION DELAY	8
4.2 MEDIA STREAM DELAY DISTRIBUTION	8
4.3 ACTIVE FRAME INTER-ARRIVAL TIME	8
4.4 ACTIVE FRAME INTER-ARRIVAL TIME DISTRIBUTION	9
4.5 ELEMENTARY FRAME RATE	9
4.6 FRAME RATE STATISTICS	9
5 TEMPORAL CALCULATIONS FOR GENERAL COMMUNICATION MEDIA	9
5.1 SINGLE CHANNEL CALCULATIONS	10
5.2 MEDIA FRAMES	10
5.3 SYNCHRONIZATION CALCULATIONS	11
6 VIDEO MEASUREMENTS	12
6.1 COLLECTING VIDEO FRAMES FOR MEASUREMENTS	12
6.1.1 <i>Description of Video Frames</i>	12
6.1.2 <i>Video Frames at the NTSC Composite Interface</i>	12
6.1.2.1 <i>Analog to Digital Conversion</i>	13
6.1.2.2 <i>Time Stamp Assignment</i>	14
6.1.2.3 <i>Gain, Active Area, and Spatial Alignment</i>	14
6.1.2.4 <i>Recognized Options</i>	14
6.1.3 <i>Video Frames at the 525-line Digital Component Interface</i>	15
6.1.3.1 <i>Signal Organization</i>	15
6.1.3.2 <i>Time Stamp Assignment</i>	15
6.1.3.3 <i>Gain, Active Area, and Spatial Alignment</i>	16
6.2 MEAN SQUARE ERROR METHODS OF MEASUREMENT FOR VIDEO	16
6.2.1 <i>General</i>	16
6.2.2 <i>Calibrating the Minimum Distinguishable Difference Between Frames</i>	17
6.2.3 <i>Testing a Sequence for Distinguishable Differences</i>	18
6.2.4 <i>Categorizing Active Frames and Repeated Frames</i>	19
6.2.5 <i>Testing for Correspondence Between Frames (Matching Frames)</i>	19
6.2.6 <i>Source Sequence Qualification for the Mean Square Error Methods</i>	20
6.2.7 <i>Considerations for use of 3:2 Pull-Down Source Sequences</i>	21
6.2.8 <i>Factors That Influence Measurement Accuracy and Stability</i>	22
6.3 IN-FRAME TIME CODE METHODS OF MEASUREMENT FOR VIDEO	22
7 AUDIO MEASUREMENTS	23
7.1 COLLECTING AUDIO FRAMES FOR MEASUREMENTS	23
7.1.1 <i>Description of Audio Frames</i>	23
7.1.2 <i>Analog to Digital Conversion</i>	23
7.1.3 <i>Time Stamp Assignment</i>	23
7.2 DELAY MEASUREMENT FOR AUDIO	23
7.2.1 <i>Signal Preparation and Level Normalization</i>	26
7.2.2 <i>Coarse Average Delay Measurement</i>	26
7.2.3 <i>Activity Detection</i>	26
7.2.4 <i>Delay Tracking</i>	26
7.2.5 <i>Refinement of Delay Measurements</i>	27

7.2.6	Short Segment Correction	27
7.2.7	Extension of Valid Measurements	28
7.2.8	The Special Case of Measuring Fixed Delays	28
7.2.9	Complete Delay Measurement Algorithm	29
7.3	ALGORITHM PERFORMANCE	30
8	COMBINED AUDIO/VIDEO MEASUREMENT CONSIDERATIONS	31
8.1	AUDIO/VIDEO CHANNEL ACTIVITY AND SYNCHRONIZATION MEASUREMENTS	31
8.2	ASSOCIATING INDIVIDUAL MEASUREMENTS	32
9	DATA MEASUREMENTS	32
9.1	COLLECTING LATENCY FRAMES FOR MEASUREMENT	32
9.2	DELAY MEASUREMENT FOR DATA	33
10	TIMER STABILITY AND SYNCHRONIZATION REQUIREMENTS	34
10.1	RESOLUTION	35
10.2	ACCURACY AND STABILITY (ADJUSTABLE TIME INTERVAL ERROR)	35
10.3	TIME SETTING ERROR	38
A	TIME STAMP ASSIGNMENT	39
B	MATHEMATICAL SYMBOL AND CONVENTION KEY	41
B.1	VARIABLES USED IN CLAUSE 7	42
B.2	VARIABLES USED IN CLAUSE 9	43
B.3	VARIABLES USED IN CLAUSE 10	43
C	BIBLIOGRAPHY	44
D	AUDIO DELAY MEASUREMENT ALGORITHM	45

TABLE OF FIGURES

FIGURE 1 - USER-TO-USER CHANNELS IN A MULTIMEDIA SYSTEM	2
FIGURE 2 - END-TO-END MEASUREMENT	3
FIGURE 3 - REMOTE DIGITAL LOOP-BACK MEASUREMENT	3
FIGURE 4 - LOCAL SYSTEM MEASUREMENT	3
FIGURE 5 - REMOTE VIDEO LOOP-BACK MEASUREMENT	4
FIGURE 6 - A GENERAL MODEL FOR PRESENTATION UNITS	9
FIGURE 7 - EXAMPLE VIDEO SEQUENCE HIERARCHY	12
FIGURE 8 - NTSC VIDEO SEQUENCE HIERARCHY	13
FIGURE 9 - RECOMMENDED COORDINATES FOR VIDEO FRAME DIGITIZATION	13
FIGURE 10 - FLOW DIAGRAM FOR MSE-BASED VIDEO MEASUREMENTS	17
FIGURE 11 - AUDIO CONTENT AND CODING HIERARCHIES	23
FIGURE 12 - FUNCTIONAL BLOCK DIAGRAM FOR MEASUREMENT OF TIME-VARYING AUDIO DELAYS	25
FIGURE 13 - FUNCTIONAL BLOCK DIAGRAM FOR COMPLETE ALGORITHM FOR MEASURING FIXED OR TIME VARYING AUDIO DELAYS	30
FIGURE 14 - CORRESPONDENCE BETWEEN INPUT AND OUTPUT DATA FRAMES	34
FIGURE 15 - MTIE WITH TIME REFERENCE	36
FIGURE 16 - INTERNAL TYPE A CLOCK MTIE SPEC. (DURING MEASUREMENTS)	37
FIGURE 17 - INTERNAL TYPE B CLOCK MTIE SPEC. (DURING MEASUREMENTS)	37
FIGURE A.1 - EXAMPLE FRAME TIMELINES	39
FIGURE A.2 - EXAMPLE VIDEO FORMAT CONVERSION TIMELINES	40

TABLE OF TABLES

TABLE 1 - PREFERRED AUDIO FRAME LENGTH	11
--	----

American National Standard for Telecommunications –

Multimedia Communications Delay, Synchronization, and Frame Rate

1 SCOPE, PURPOSE, & APPLICATION

1.1 Scope

This standard covers test methodologies for multimedia transmission systems utilizing digital transport facilities. It gives a set of measurement parameters, without providing limits, to characterize the following aspects of system performance:

- a) Active Video Frame inter-arrival time, which is the reciprocal of the elementary frame rate;
- b) Visual channel transmission time, also called video delay;
- c) Audio channel transmission time (or audio delay);
- d) Data channel transmission time or delay (and frame inter-arrival time);
- e) Temporal synchronization between channels.

This standard specifies methods of measurement for these parameters in the applications described in 1.3. The standard's scope is limited to cases where appropriate media input and output interfaces are present, or where these interfaces can be made available with optional test fixtures.

The following applications are beyond the scope of this standard:

- a) *Measuring aspects of system performance other than delay, synchronization, and frame rate.* It is important to point out that delay, synchronization, and frame rate measurements do not completely characterize the quality of a multimedia transmission system. For example, the reproduction quality of Video Frames from input to output is also of obvious importance to users. Subjective test methods employing representative users yield the best available assessment of video transmission quality. The optimization of such subjective performance for all quality parameters may take precedence over the optimization of the result of parametric measurements performed according to this standard. The bibliography lists several international recommendations on subjective assessment methods for entertainment and teleconference quality video transmission systems. It also lists standards for assessment of audio and data channels.
- b) *Unrestricted choice of useful and representative source content.* The methods of measurement specified here require restrictions on their source signals for testing. Video source sequences with high motion activity often cause increased delay, decreased frame rate, and skewed audiovisual synchronization in some multimedia applications. Therefore, measurements should use test scenes which are realistic for the application of the multimedia system under evaluation. Continuous audio tones or still video sequences will produce ambiguous delay measurements (but delay is of limited importance under these conditions). Other limitations are given in the sections for each measurement method.
- c) *Measuring the performance aspects of systems where the input and output interfaces are not accessible.*